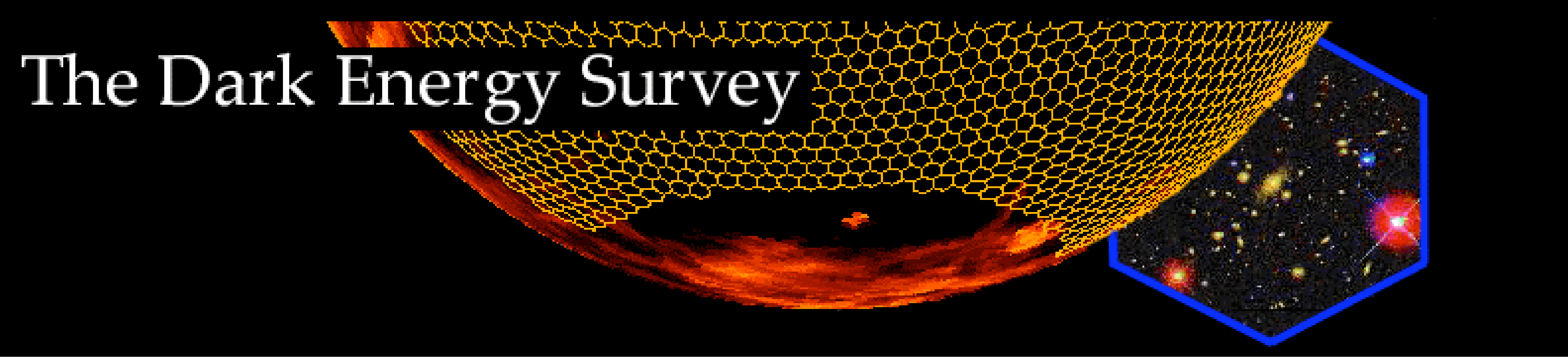


The Dark Energy Survey, Strong Lensing, and maybe Simon Newcomb

Jim Annis
Center for Particle Astrophysics

The Dark Energy Survey

- Study Dark Energy using

  4 complementary* techniques:

  I. Cluster Counts

  II. Weak Lensing

  III. Baryon Acoustic Oscillations

  IV. Supernovae

- Two multiband surveys:

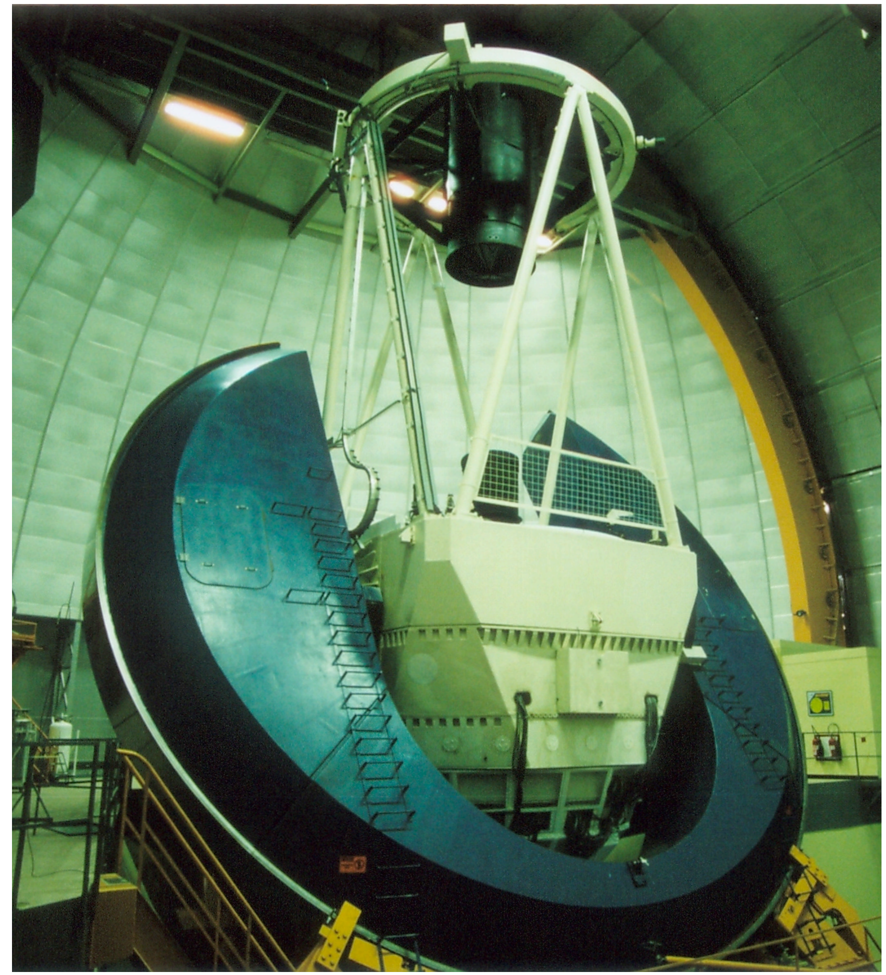
  5000 deg^2 *g, r, i, Z, Y* to *i~24*

  9 deg^2 repeat (SNe)

- Build new 3 deg^2 camera

  and Data management system

  Survey 30% of 5 years



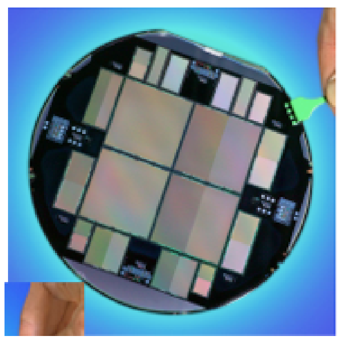
*in systematics & in cosmological parameter degeneracies
*geometric+structure growth: test Dark Energy vs. Gravity

DARK ENERGY SURVEY

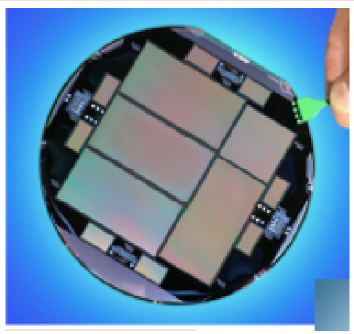
DECam Introduction

LBNL full depletion CCDs

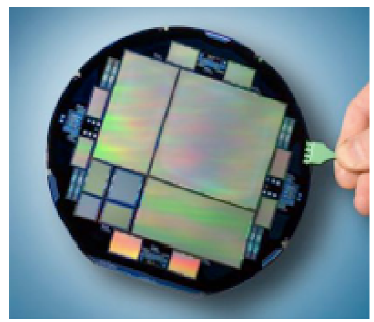
High QE @900nm



SNAP
4 3.5k x 3.5k
10 μm pixels

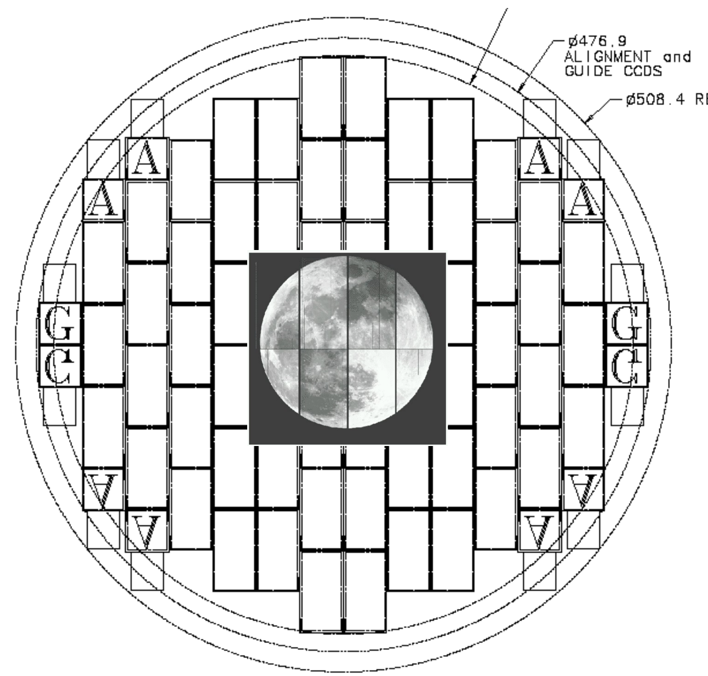


DES
4 2k x 4k
15 μm pixels



BOSS
1 4k x 4k
15 μm pixels

DECam Focal Plane



62 2kx4k Image CCDs: 520 MPix
8 2kx2k focus, alignment CCDs
4 2kx2k guide CCDs

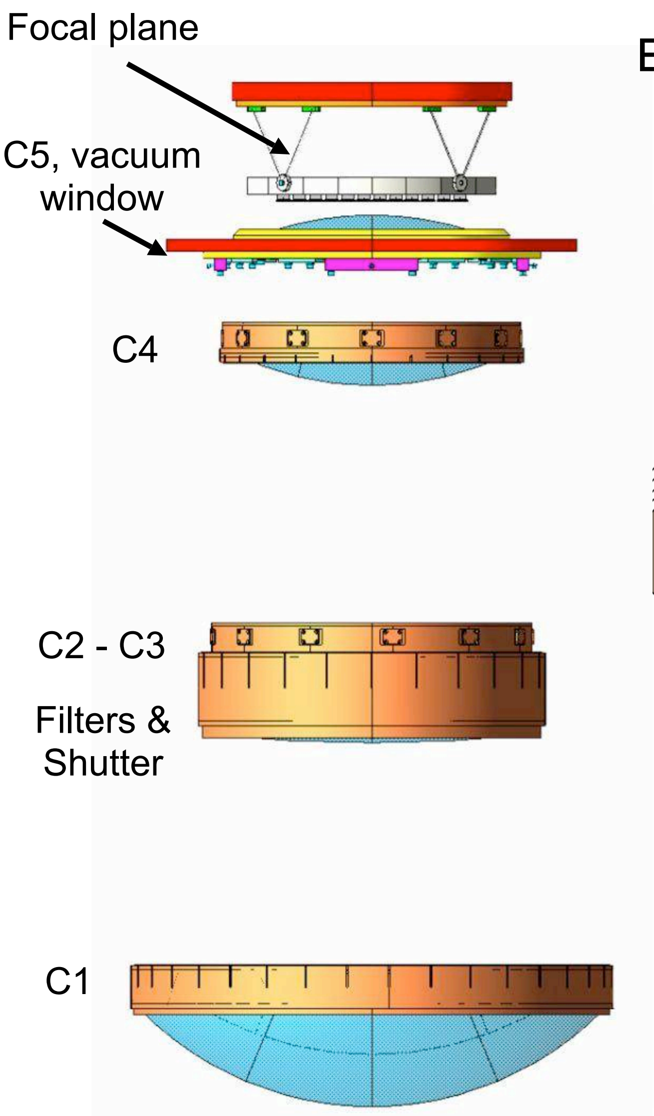
Fermilab packaging and testing the CCDs

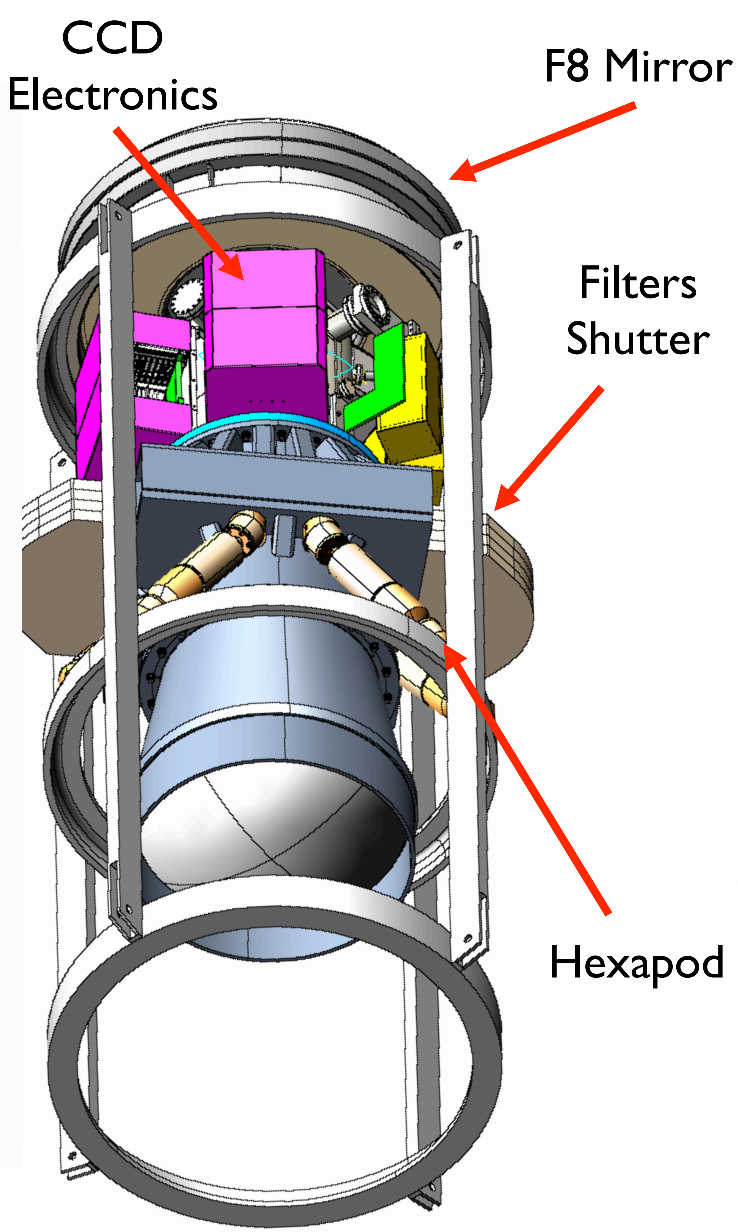
4-side abutable science package

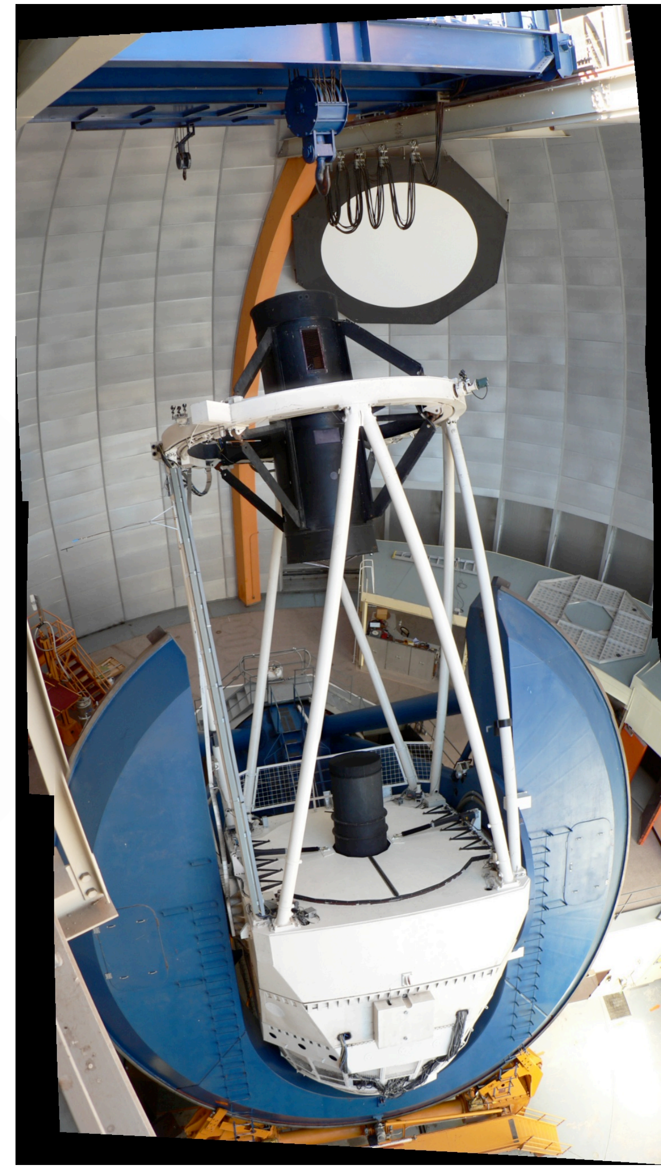
Michigan/UCL optical design

FWHM: ~ 0.25”   2.2 deg FOV   400-1000μm

DECam Introduction





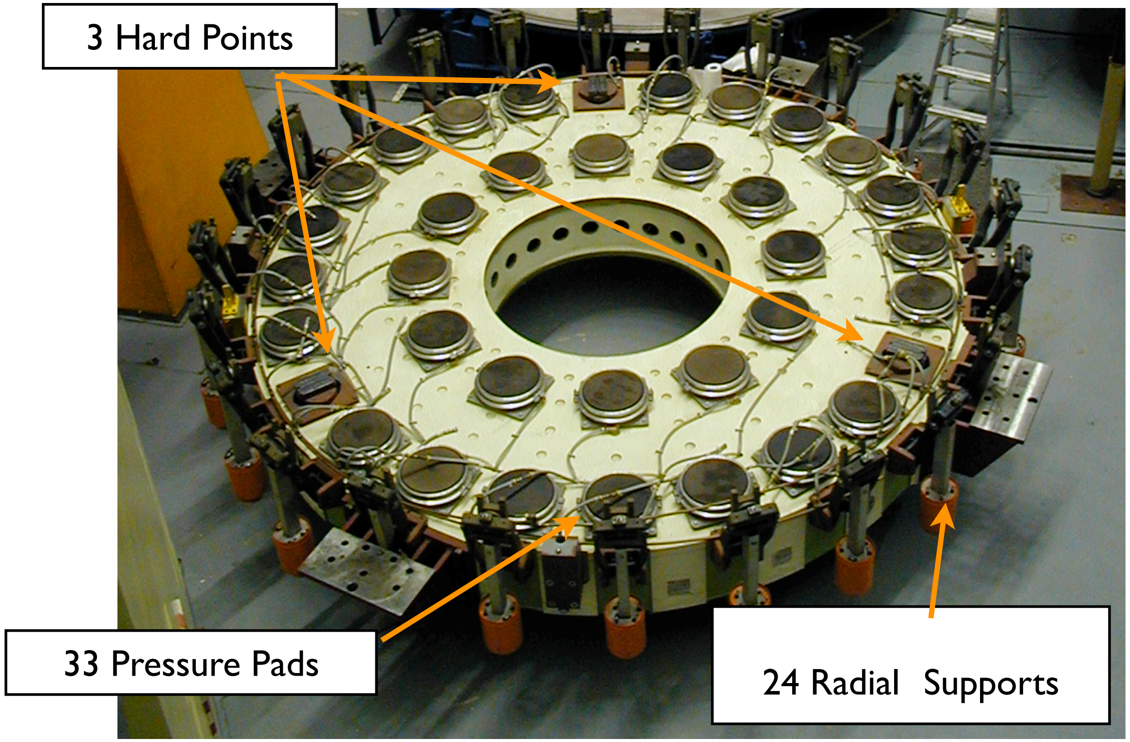


2.2 degrees, ~1 meter

DARK ENERGY SURVEY

CTIO Blanco

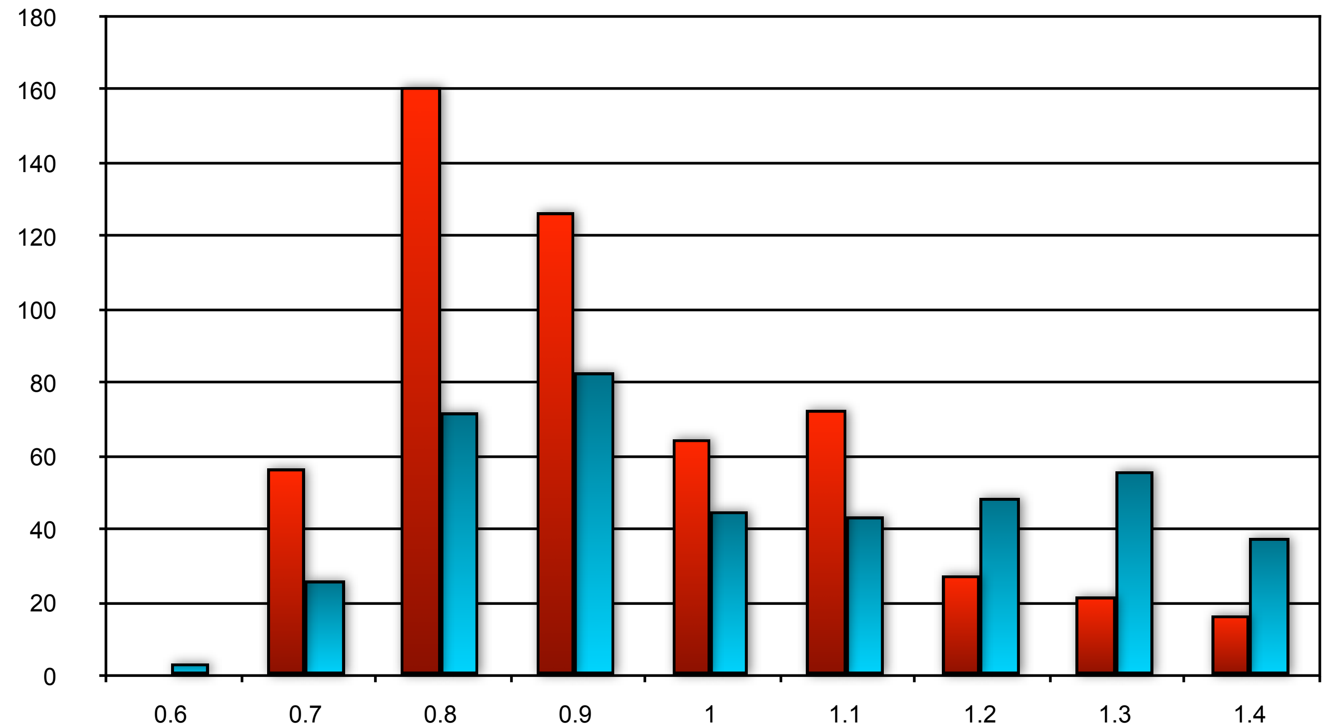
- The Blanco was the last of the great equatorials
  - Hale, Lick, Mayall, AAT
  - i.e., a proven design,
  - i.e., 70's technology
- Solid primary mirror
  - 50cm thick Cervit
  - weighs 15 tons
- Mechanical mirror support system
  - radial: purely mechanical
  - axial: 3 load cell hard points + controllable support cells



Blanco seeing

pre- and post-shutdown Oct/Nov 2005

CTIO now understand this telescope better than ever before.



Not in the same class as Magellan, but perfectly capable of sub-arcsecond imaging without active control of optical axis and with a corrector with known “issues”

Plenum removed, radial supports repaired, partially retuned and rebalanced

Simulations are Important to DES

DARK ENERGY SURVEY

- non-linear evolution of the matter density
  - P(k) for weak lensing, BAO
  - halo characterization for clusters, BAO, weak lensing
  - sensitivity to baryonic physics

Gaztanaga, Fosalba, Castender, Manera, Kravtsov, Rudd, Ricker

- gas dynamic simulations of clusters
  - form of cluster observable-mass reln's : $p(y_{SZ}, N_{gal}, \ldots \mid M,z)$
  - sensitivity to galaxy/AGN physics

Kravtsov, Rudd, Ricker, Stanek, Nord, Evrard

- mock sky surveys of galaxies and clusters
  - tune optical + SZ cluster finding algorithms
  - test cluster self-calibration: feed `end-to-end' analysis pipeline
  - refine techniques to model galaxy formation and evolution

    empirical: halo occupation, ADDGALS

    first principle: SAM's, direct gas dynamic simulation

Wechsler, Weinberg, Nord, Stanek, Rasia, Evrard, Lin, Stoughton

DES Forecasts: Power of Multiple Techniques

- Study Dark Energy using

  4 complementary techniques:

  I. Cluster Counts

  II. Weak Lensing

  III. Baryon Acoustic Oscillations

  IV. Supernovae

Assumptions:

Clusters:

σ_8=0.75, z_{max}=1.5,

WL mass calibration

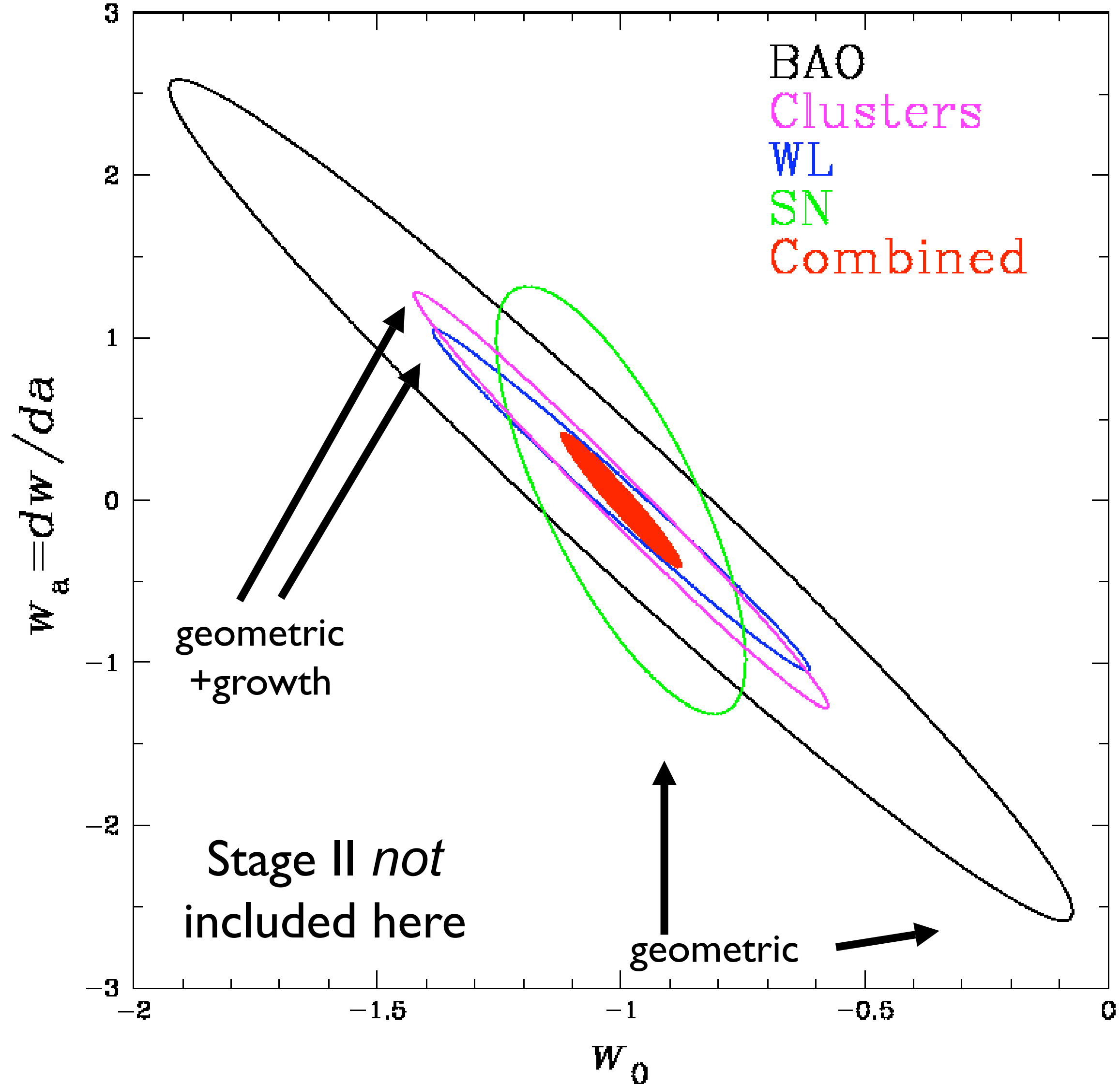
BAO: ℓ_{max}=300 WL: ℓ_{max}=1000 (no bispectrum)

Statistical+photo-z systematic errors only

Spatial curvature, galaxy bias marginalized, Planck CMB prior

Factor 4.6 improvement over Stage II

$w(z) = w_0 + w_a(1-a)$ 68% CL



DETF Figure of Merit: inverse area of ellipse

Photo-z

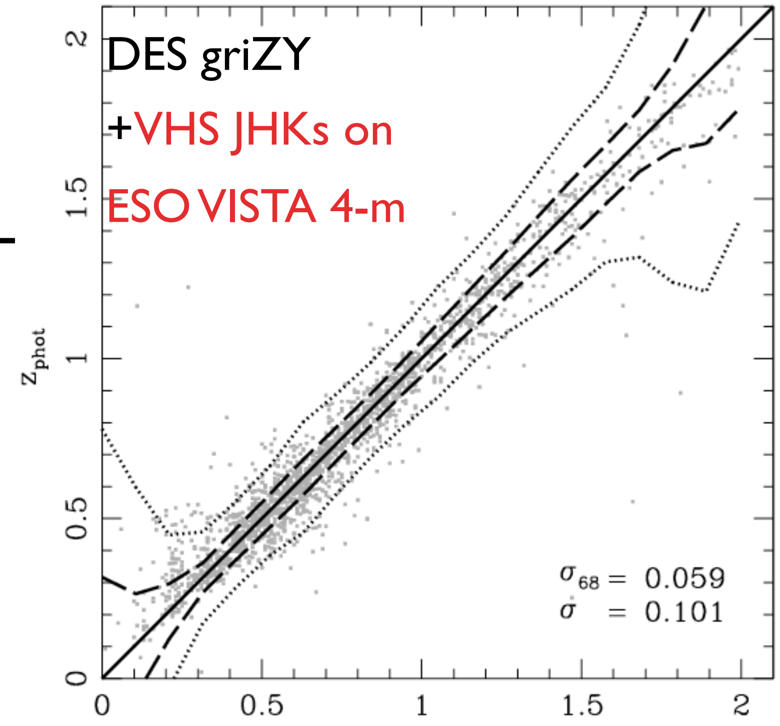
DES +VHS*

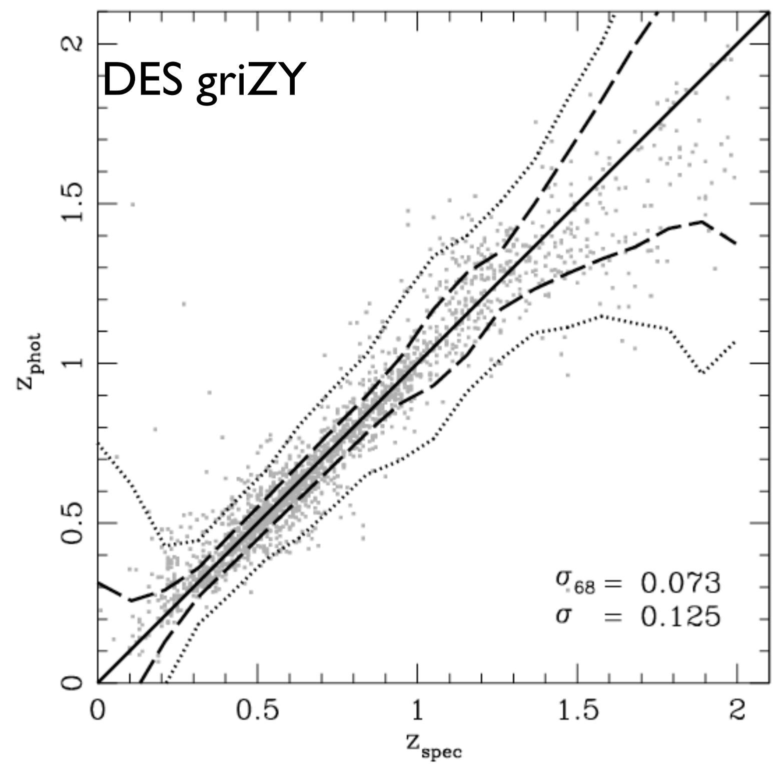
10σ Limiting Magnitudes

g	24.6		
r	24.1	J	20.3
i	24.0	H	19.4
Z	23.8	Ks	18.3
Y	21.6		

+2% photometric calibration error added in quadrature

Photo-z systematic errors under control using *existing* spectroscopic training sets to DES photometric depth





10m South Pole Telescope (SPT)

John Carlstrom's project

- 1000 element bolometer array
- 1.25' resolution
- 4000 sq-degree SZ survey
- taking data!

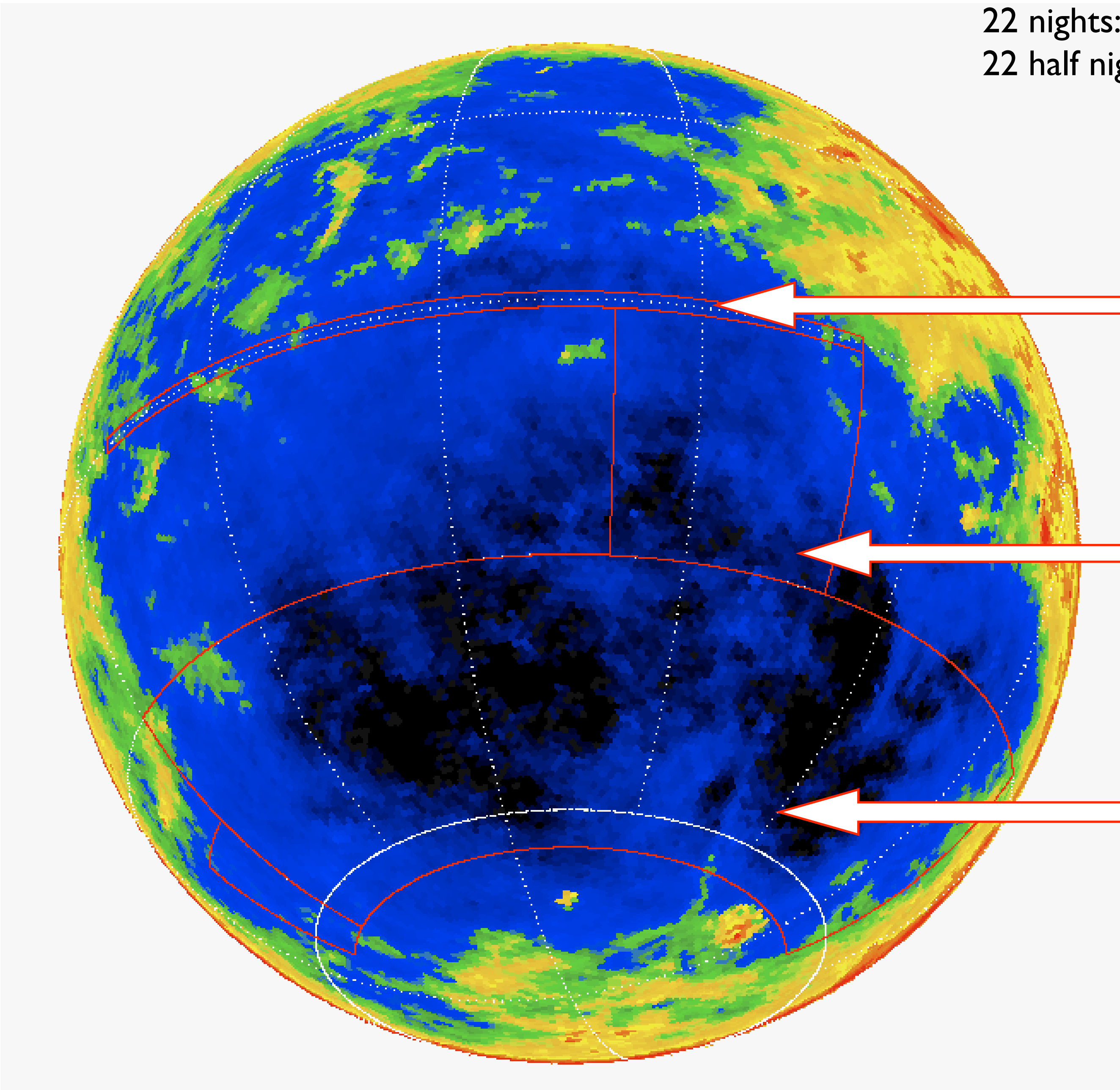
DES survey area overlaps SPT area

- aimed at photo-z plus cluster physics
- SZ has low-scatter mass estimators

The DES Survey Area

NOAO time allocation: 5 years at

22 nights: September, October, November, December
22 half nights: January, February



SDSS Stripe 82
-50 < RA < 50 -1 < Dec < 1
200 sq-degrees
Overlap redshift surveys

Connection region
20 < RA < 50 -30 < Dec < -1
800 sq-degrees

SPT Area
-60 < RA < 105 -65 < Dec < -30
-75 < RA < -60 -65 < Dec < -45
4000 sq-degrees
Overlap SZ survey

DES Schedule Goals

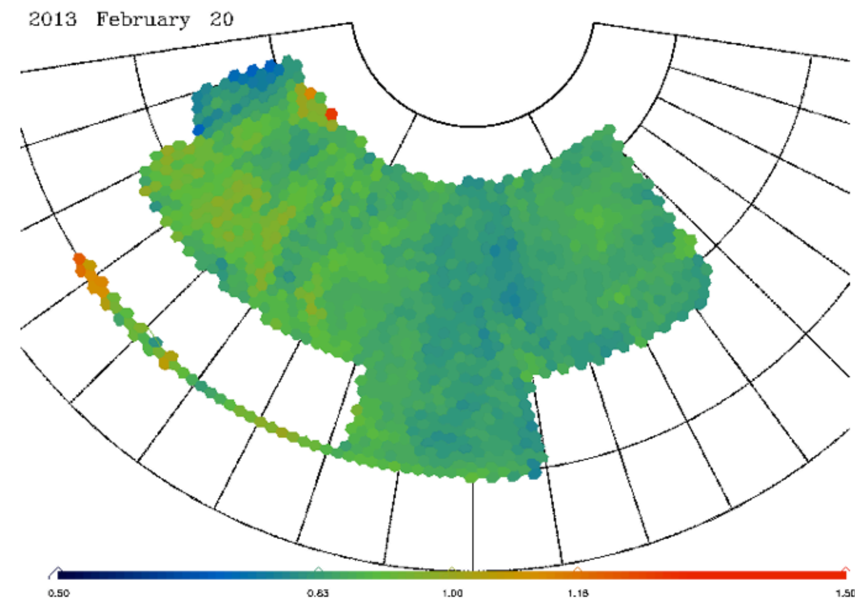
- September 2009: DECam maintenance facility operational at CTIO
- January 2010: New Telescope Controls System operational on the Blanco
- April 2010: Commission the DES DM at NCSA and transfer simulated data through the DTS to NCSA.
- April 2010: Deliver a partial SISPI system to CTIO and begin the integration of SISPI with the telescope controls system, the DTS, and the DES DM system.
- July 2010: Deliver DECam to CTIO.
- July 2010: Deliver the Optical Corrector to CTIO.
- Complete commissioning and make the first science observations while the South Galactic Cap is visible between September 2010 and March 2011.

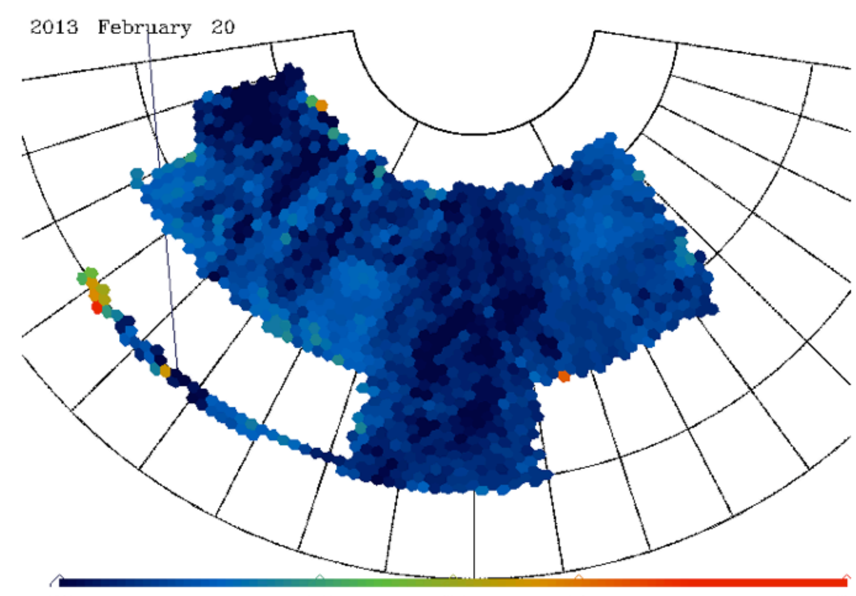
How the Survey Proceees

- Aim is to produce substantial key project science afte rscond observing season
- Best way to think about this is in tilings, one complete coverage of the survey area
- Survey can perform 8 tilings per year @ 100 sec exposures
  - Year 1 g,r,i,z = 24.2 23.7 23.3 22.6 10σ galaxues
  - Year 2 g,r,i,z = 24.6 24.1 23.6 23.0 $\mu_{g,r,i,z}$ (5σ)= 25.3 24.8 24.3 23.7 mags/sq-arcsec
  - Year 3 i,z = 24.0 23.4
  - Year 4 i,z = 24.3 23.6
  - Year 5 z = 23.9
    - We are uniformly conservative in our claims:
      - 0.9”
      - g,r,i,z = 24.6, 24.1, 24.3, 23.9 (10σ, galaxies) = 26.1, 25.6, 25.8, 25.4 (5σ, psf)
      - are we going to 24th or 26th magnitude?

Seeing

- The top plot shows i-band 2-year/ 4 tiling mean seeing.
    - The left half has larger seeing than the right half.
    - A reflection of the seeing being better in December-February than in September-October.
- The bottom plot shows what occurs if one takes the single best image for each hex
    - The seeing distribution peaks at a smaller value, obviously.
    - The distribution is more gaussian and narrower: σ= 0.18 vs σ= 0.1





Arc predictions

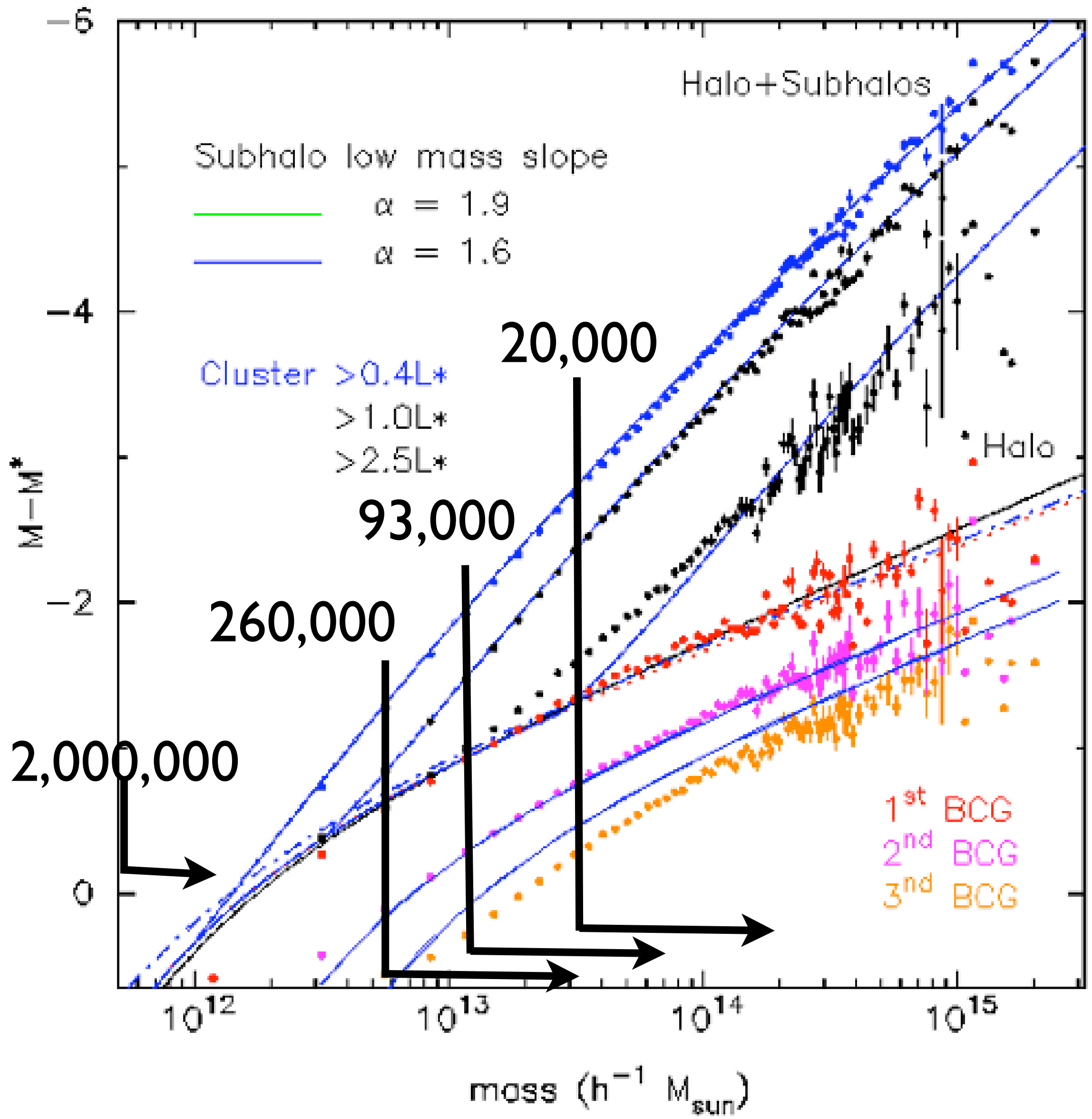
~0.75" seeing

- Year 2 g,r,i,z = 24.6 24.1 23.6 23.0 $\mu_{g,r,i,z}$ (5σ)= 25.3 24.8 24.3 23.7 mags/sq-arcsec

- ?
- Ask Martin, Eduardo, or Joe
- DES at 2 years is comparable to RCS
  - 1/2 mag deeper
  - 50 times more area
  - ~1000?

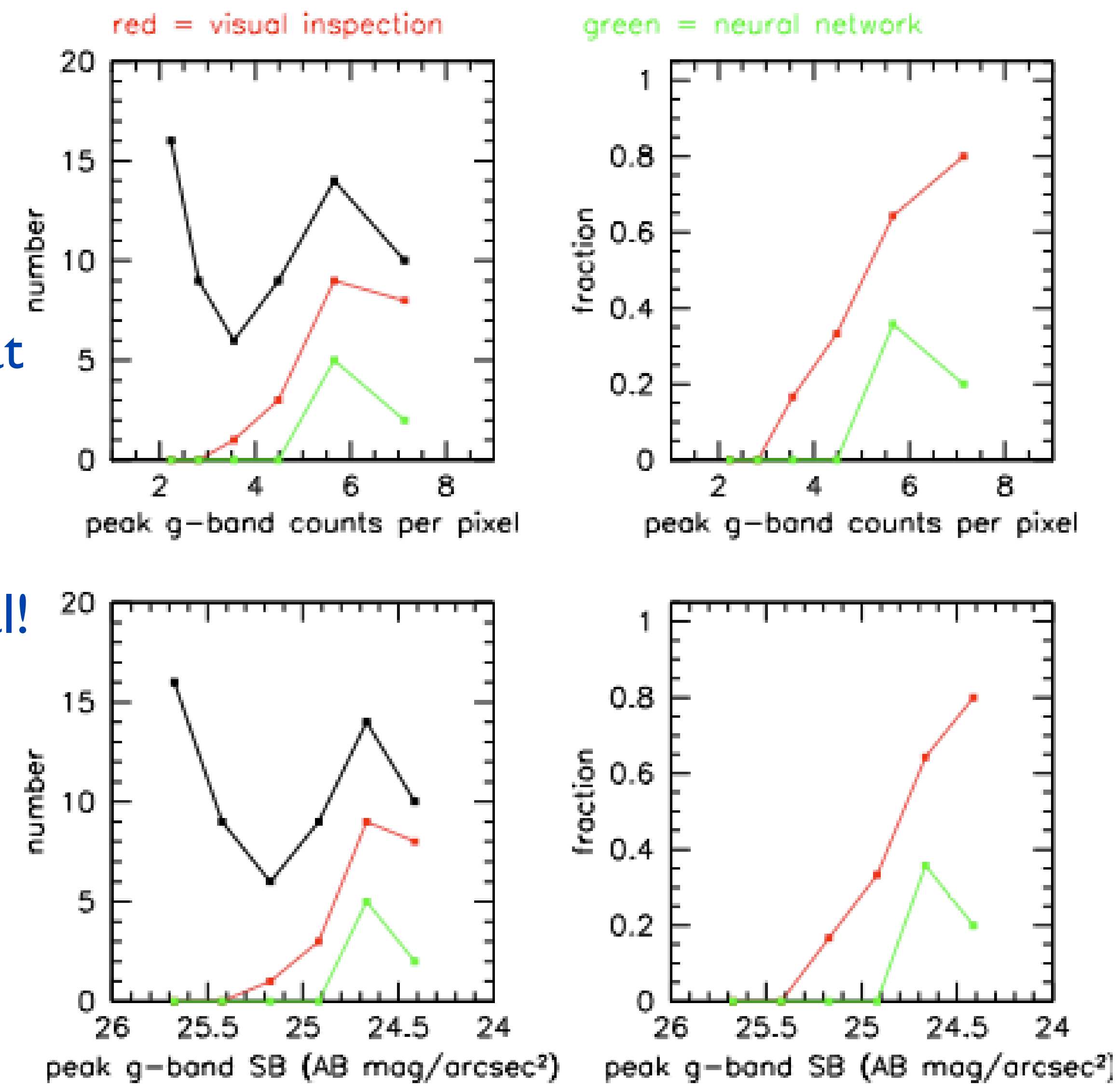
Survey Mode Arc Finding

- MaxBCG cluster catalog
  - $0 < z < 0.32$
  - few $x10^4$ clusters
  - few $x10^5$ groups
  - few $x10^6$ red L* galaxies
- SDSS North has ~400,000 fields
- You are going to have to look at every image anyway. Just do it.
  - blank sky (arcfinder)
  - around red galaxies
    - I can deal with projects that take 1min/image over the whole SDSS



Selection function and false positives

- At some level, surveys don't care about faint arcs.
  - there exists HST, SuprimeCam...
  - rare high SB objects!
- The rate of false negatives isn't that important
  - within reason and
  - with a selection function
- The rate of false positives is crucial!
  - 1 per image is too many
  - the point is not to make an eye survey more efficient, the point is to find arcs with a known selection function
  - 1 per hundred images is closer
- Post processor is not a trivial stage
  - neural nets
  - bounded decision trees..



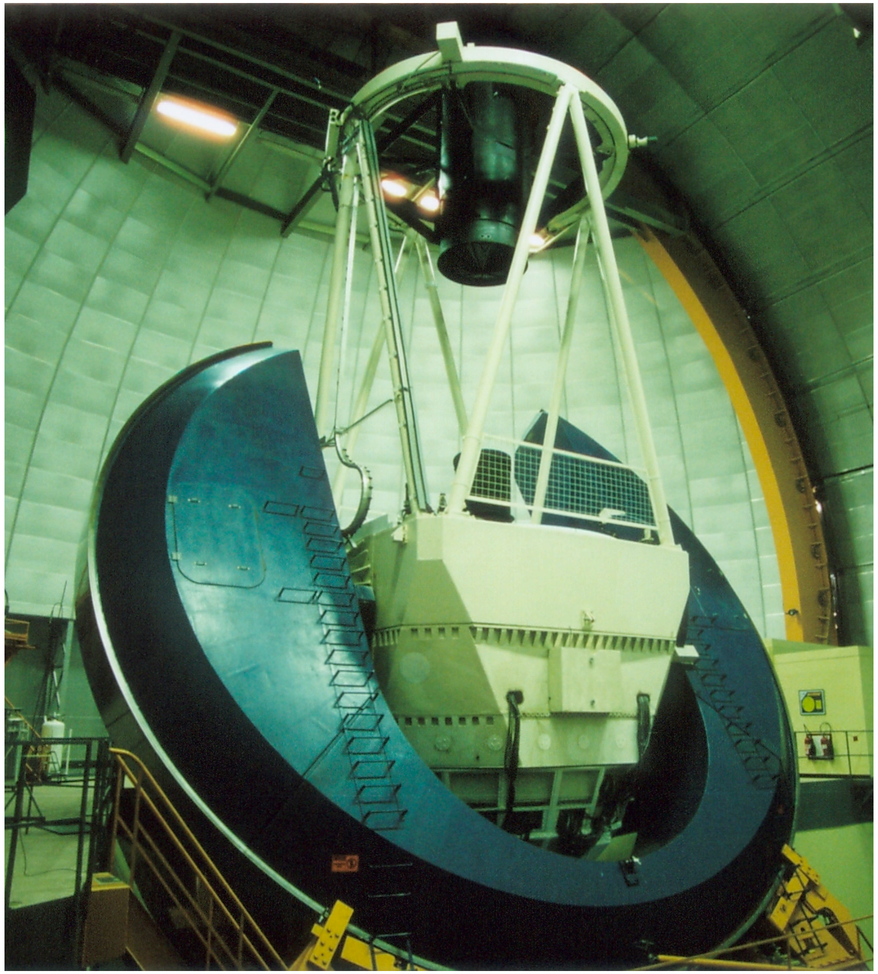
Estrada et al 2007
see Scarpine's poster

The Dark Energy Survey

- Study Dark Energy using
  4 complementary techniques:
  I. Cluster Counts
  II. Weak Lensing
  III. Baryon Acoustic Oscillations
  IV. Supernovae

Start date targeted for fall 2010

DECam itself open to the community 70% of the year



The Dark Energy Survey..... so, which is it?

Are we fundamentalist or just plain evil?

Fundamentalist physics: why Dark Energy is bad for Astronomy

Simon D.M. White

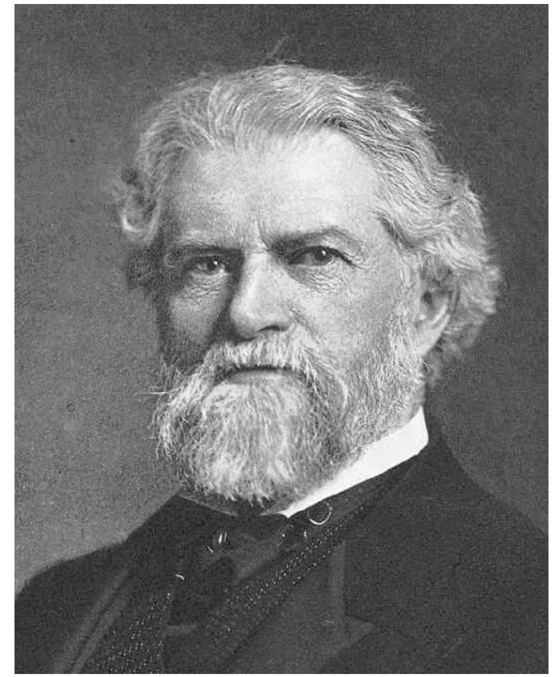
Max Planck Institute for Astrophysics, Garching bei München, Germany

Astronomers carry out observations to explore the diverse processes and ob-

In this essay I argue that this convergence can be damaging for astronomy. The two communities have different methodologies and different scientific cultures. By uncritically adopting the values of alien system, astronomers risk undermining the foundations of their own current success and endangering the future vitality of their field.

the values of an alien system, astronomers risk undermining the foundations of their own current success and endangering the future vitality of their field. Dark Energy is undeniably an interesting problem to attack through astronomical observation, but it is one of many and not necessarily the one where significant progress is most likely to follow a major investment of resources.

A Tale of Two Simons



Simon White
Distinguished Astronomer of the late 20th Century

Simon Newcomb
Distinguished Astronomer of the late 19th Century

The Old Astronomy

- Simon Newcomb was the foremost astronomer of his day.
  - Anything but dumb-
    - worked with Michaelson on the speed of light
      - got a better answer, too...
    - his calculations form the basis of the Astronomical Almanac
- But above all he was a mathematical astronomer
  - “Traditional Astronomer”
  - the prevailing view of astronomy as second only to mathematics among the exact sciences imposed high standards on its professional practitioners in terms of the subjects they could pursue and the methods they could use. Astronomy "must lay down the rules for determining the motions of the heavenly bodies as they appear to us from the earth", declared Friedrich Wilhelm Bessel (1784-1846), positional astronomer *par excellence*. "Everything else that can be learned about the heavenly bodies ... is not properly of astronomical interest"

Spectroscopy and the rise of Astrophysics
http://e3.uci.edu/clients/bjbecker/astrophysics.html

DARK ENERGY SURVEY

The New Astronomy

In the late 19th century, many traditional astronomers viewed astrophysics as an upstart that would not endure...

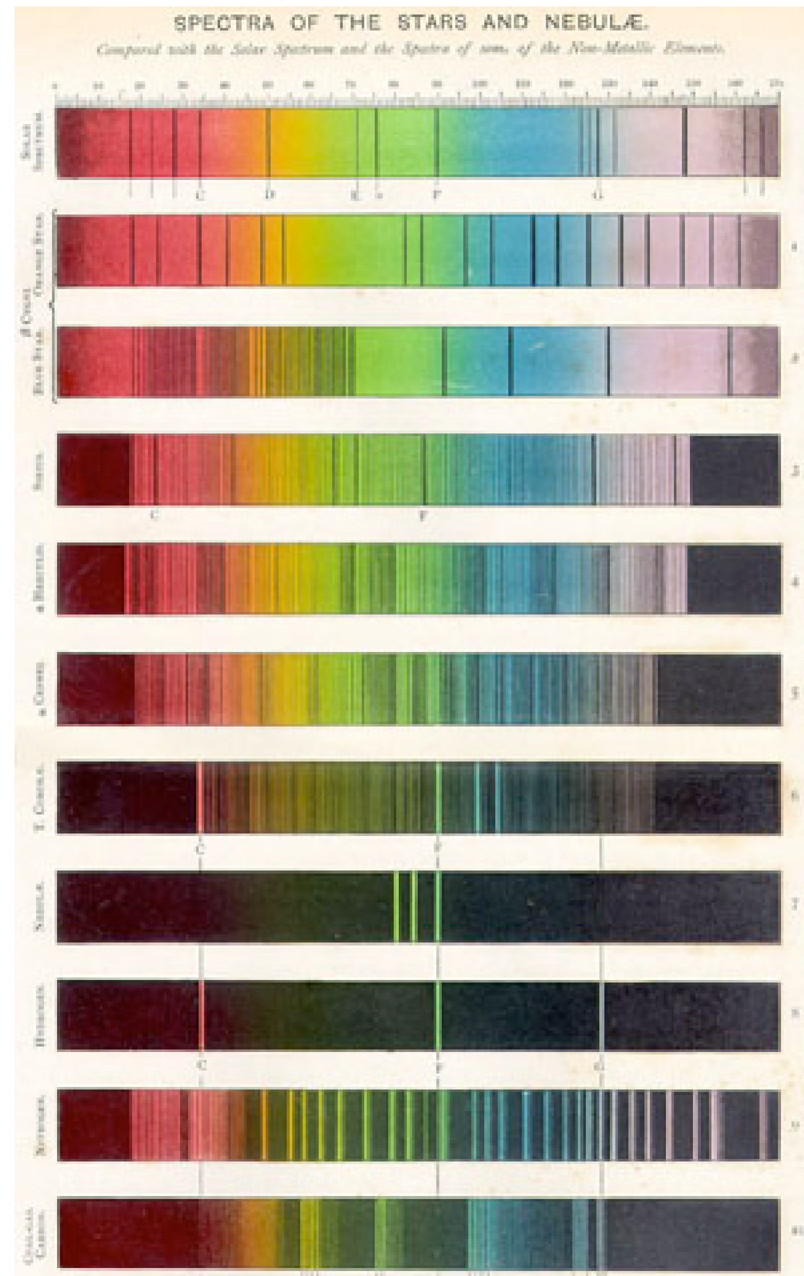
...many professional astronomers were investigating astrophysical phenomena, utilizing new astrophysical techniques like spectroscopy.

...emphasis on stellar spectra and the application of a newly developing physical understanding of the microscopic nature of matter, astrophysics was a considerable depature from ealier astronomy, with both respect to instrumentation used and the basic physical laws employed

Simon Newcomb.... [traditional mathematical positional astronomer held the opposite view from] George Ellery Hale..[discovered magnetic fields on the Sun], and opposed Hale's efforts to form the American Astrophysical Society

The American Astronomical Societies First Century

Shall we imagine Simon's astroph paper?



DARK ENERGY SURVEY

Simon Newcomb's provocative paper...

Fundamentalist physics: why Astrophysics is bad for Astronomy

Simon Newcomb

Director, American Nautical Almanac

Astronomers carry out observations to explore the diverse processes and objects which populate our Universe. High energy physicists carry out experiments

In this essay I argue that this convergence can be damaging for astronomy. The two communities have different methodologies and different scientific cultures. By uncritically adopting the values of alien system, astronomers risk undermining the foundations of their own current success and endangering the future vitality of their field.

the values of an alien system, astronomers risk undermining the foundations of their own current success and endangering the future vitality of their field. Dark Energy is undeniably an interesting problem to attack through astronomical observation, but it is one of many and not necessarily the one where significant progress is most likely to follow a major investment of resources.

BTW, he would have been right-
as soon as the astrophysicists got involved, astronomy lost its standing as a must-be studied/taught subject, right up there with mathematics, and positional astronomy has never regained its forefront status

- Look- surveys are a rich source of science, for a much wider set of scientists than only those with access to the best.

- The SDSS didn't just produce the power spectrum papers, its main goal as stated to the funding agencies.
  - yes, there were the
    - 4 Tegmark papers and the
    - Eisenstein LRG/BAO paper

- but there was also...

http://www.sdss.org/publications/index.html

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Sloan Digital Sky Survey

Mapping the Universe

Scientific and Technical Publications

Scientific papers are based on analyses of, or presentations of, the SDSS data. Data Release papers describe the specific process for each data release. Technical papers describe the SDSS instrumentation, calibration, software, strategy, and targeting algorithms. Technical papers may include some SDSS data for illustrative purposes. This list represents the definitive list of SDSS papers submitted to peer-reviewed journals. Other Publications Based on SDSS Data is a list of publications in journals and astro-ph which use public SDSS data.

Scientific Publications

Title	First Author	astro-ph	Journal
A MaxBCG Catalog of 12,875 Galaxy Clusters from the Sloan Digital Sky Survey	B. Koester	0701268	ApJ accepted
Luminosity dependence of the spatial and velocity distributions of galaxies: Semi-analytic models versus the Sloan Digital Sky Survey	C. Li	0701218	MNRAS submitted
Clustering Analyses of 300,000 Photometrically Classified Quasars--II. The Excess on Very Small Scales	A. Myers	0612191	ApJ accepted
Clustering Analyses of 300,000 Photometrically Classified Quasars--I. Luminosity and Redshift Evolution in Quasar Bias	A. Myers	0612190	ApJ accepted
Environment-Dependence of Properties of Galaxies in the Sloan Digital Sky Survey	C. Park	0611610	ApJ accepted
Internal and Collective Properties of Galaxies in the Sloan Digital Sky Survey	Y. Choi	0611607	ApJ accepted
The UV Properties of SDSS Selected Quasars	G. Trammell	0611549	AJ accepted
The Peculiar SN 2005hk: Do Some Type Ia Supernovae Explode as Deflagrations?	M. M. Phillips	0611295	PASP submitted
SDSS J1029+2623: A Gravitationally Lensed Quasar with an Image Separation of 22.5 Arcseconds	N. Inada	0611275	ApJL 653:97 (2006)
Topology of Structure in the Sloan Digital Sky Survey: Model Testing	J. Gott	0610762	ApJ submitted
Broad Absorption Line Variability in Repeat Quasar Observations from the SDSS	B. Lundgren	0610656	ApJ submitted
Low-Mass Dwarf Template Spectra from the SDSS	J. Bochanski	0610639	AJ 133:531 (2007)
The Clustering of Galaxy Groups: Dependence on Mass and other Properties	A. Berlind	0610524	ApJ submitted
3.6-7.9 um Photometry of L and T Dwarfs and the Prevalence of Vertical Mixing in their Atmospheres	S. Leggett	0610214	ApJ accepted
Galaxy Colour, Morphology, and Environment in the Sloan Digital Sky Survey	N. Ball	0610171	MNRAS submitted
A New Survey for Giant Arcs	J. Hennawi	0610061	AJ submitted
Using the Galactic Dynamics of M7 Dwarfs to Infer the Evolution of their Magnetic Activity	A. West	0609001	AJ 132:2507 (2006)
Model Atmosphere Analysis of the Weakly Magnetic DZ White Dwarf G165-7	P. Dufour	0608065	ApJ 651:1112 (2006)
Cluster Lensing in the SDSS I: Weak Lensing Profiles	E. Sheldon		ApJ submitted
Cats and Dogs, Hair and a Hero: A Quintet of New Milky Way Campanions	V. Belokurov	0608448	ApJ 654:897 (2007)
Characterizing Three Candidate Magnetic CVs from SDSS: XMM-Newton and Optical Follow-up Observations	L. Homer	0609462	AJ 132:2743 (2006)

Sloan Digital Sky Survey

http://www.sdss.org/publications/index.html

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Characterizing Three Candidate Magnetic CVs from SDSS: XMM-Newton and Optical Follow-up Observations	L. Homer	0609462	AJ 132:2743 (2006)
Two New Gravitationally Lensed Double Quasars from the SDSS	N. Inada	0609696	AJ 133:206 (2007)
Discovery of a Gravitationally Lensed Quasar from the Sloan Digital Sky Survey: SDSS~J133222.62+034739.9	T. Morokuma	0609695	AJ 133:214 (2007)
Cosmological Constraints from the SDSS Luminous Red Galaxies	M. Tegmark	0608632	PRD (2006) 123507
A Large, Uniform Sample of X-ray Emitting AGN from the ROSAT All-Sky and Sloan Digital Sky Surveys: the Data Release 5 Sample	S. Anderson	0609458	AJ 133:313 (2007)
The tully-Fisher Relation and its Residuals for a Broadly Selected Sample of Galaxies from SDSS	J. Pizagno	0608472	AJ submitted
Probing the Evolution of IR Properties of z~6 Quasars: Spitzer Observations	L. Jiang	0608006	AJ 132:2127 (2006)
The 2SLAQ Luminous Red Galaxy Survey: Evolution of the Luminosity Function to z=0.6	D. Wake	0607629	MNRAS 372 (2006) 537
A High Redshift Detection of the Integrated Sachs-Wolfe Effect	T. Giannantoni	0607572	Phys.Rev.D74 (2006) 063520
Measuring the Matter Densityusing Baryon Oscillations in the SDSS?	W. Percival	0608635	ApJ 657:51 (2007)
The Shape of the SDSS DR5 Galaxy Power Spectrum	W. Percival	0608636	ApJ 657:645 (2007)
The clustering of Narrow-Line AGN in the Local Universe	C. Li	0607492	MNRAS 373 (2006) 457
Chandra Observations of Red Sloan Digital Sky Survey Quasars	P. Hall	0606417	AJ 132:1977 (2006)
The Clustering of Luminous Red Galaxies in the Sloan Digital Sky Survey Imaging Data	N. Padmanabhan	0605302	MNRAS submitted
An Orphan in the Field of Streams	V. Belokurov	0605705	ApJ 658:337 (2007)
A Faint New Milky Way Satellite in Bootes	V. Belokurov	0604355	ApJL 647:111 (2006)
The Origin of the Bifurcation in the Sagittarius Stream	M. Fellhauer	0605026	ApJ 651:167 (2006)
The Field of Streams: Sagittarius and its Siblings	V. Belokurov	0605025	ApJL 642:137 (2006)
Hot DB White Dwarfs from the Sloan Digital Sky Survey	D. Eisenstein	0606702	AJ 132:676 (2006)
A Catalog of Spectroscopicaly Confirmed White Dwarfs from the SDSS DR4	D. Eisenstein	0606700	ApJS 167:40 (2006)(2006)
What Triggers Galaxy Transformations? The Environments of Post-Starburst Galaxies	D. Hogg	0606599	ApJ 650:763 (2006)
Panchromatic Properties of 99,000 Galaxies Detected by SDSS, and (some by) ROSAT, GALEX, 2MASS, IRAS, GB6, FIRST, NVSS and WENSS Surveys	M. Obric	0606344	MNRAS 370 (2006) 1677
The Rest-Frame Optical colors of 99,000 SDSS Galaxies	V. Smolcic	0606355	MNRAS 371 (2006) 121
Density Profiles of Galaxy Groups and Clusters from SDSS Galaxy-Galaxy Weak Lensing	R. Mandelbaum	0605476	MNRAS 372 (2006) 758 (2006)
SDSS J1534+1615AB: A Novel T Dwarf Binary Found with Laser Guide Star Adaptive Optics and Implications for the L/T Dwarf Transition	M. Liu	0605037	ApJ 647:1393 (2006)
A New Milky Way Dwarf Satellite in Canes Venatici	D. Zucker	0604354	ApJL 643:103 (2006)
The Sloan Digital Sky Survey Quasar Lens Search I. Candidate Selection Algorithm	M. Oguri	0605571	AJ 132:999 (2006)
Quasars Probing Quasars I: Optically Thick Absorbers Near Luminous Ionizing Sources	J. Hennawi	0603742	ApJ 651:61 (2006)
Type II Quasars from the Sloan Digital Sky Survey: V. Imaging Host Galaxies with HST	N. Zakamska	0603625	AJ 132:1496 (2006)
A 110 MG Cyclotron Harmonic in the Optical Spectrum of RX J1554.2+2721	A. Schwope	0603087	A&A 452:955 (2006)
A Catalog of Broad Absorption Line Quasars from the Sloan Digital Sky Survey Third Data Release	J. Trump	0603070	ApJS 165:1 (2006)
The Effect of Large-Scale Structure on the SDSS Galaxy Three-Point Correlation Function	R. Nichol	0602548	MNRAS 368 (2006) 1507

A 110 MG Cyclotron Harmonic in the Optical Spectrum of RX J1554.2+2721	A. Schwope	0603087	A&A 452:955 (2006)
A Catalog of Broad Absorption Line Quasars from the Sloan Digital Sky Survey Third Data Release	J. Trump	0603070	ApJS 165:1 (2006)
The Effect of Large-Scale Structure on the SDSS Galaxy Three-Point Correlation Function	R. Nichol	0602548	MNRAS 368 (2006) 1507
A Spectroscopic Survey of Faint Quasars in the SDSS Deep Stripe: I. Preliminary Results from the Co-added Catalog	L. Jiang	0602569	AJ 131:2788 (2006)
Chandra Observations of the Highest Redshift Quasars from the Sloan Digital Sky Survey	O. Shemmer	0602442	ApJ 644:86 (2006)
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Current Star Formation in Early-type Galaxies and the E+A Phenomenon. II The Progenitors of E+A Galaxies	Joe Helmboldt		MNRAS submitted
Current Star Formation in Early-type Galaxies and the E+A Phenomenon. I The Sample	Joe Helmboldt		MNRAS submitted
The RASS-SDSS Galaxy Cluster Survey VII: On the Cluster Mass to Light Ration and the Halo Occupation Distribution	P. Popesso		A&A submitted
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Very Small-Scale Clustering of Luminous Red Galaxies	M. Masjedi	0512166	ApJ 644:54 (2006)
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Chandra and XMM Observations of Type II Quasars from the SDSS	A Ptak	0510204	ApJ 637:147 (2006)
A Search for the Most Massive Galaxies: Double Trouble?	M. Bernardi	0510696	AJ 131:2018 (2006)
Spectral Decomposition of Broad-Line AGNs and Host Galaxies	D. Vanden Berk	0509332	AJ 131:84 (2006)

Gas Infall and Stochastic Star Formation in Galaxies in the Local Universe	G. Kauffmann	0510403	MNRAS 367:1394 (2006)
Chandra and XMM Observations of Type II Quasars from the SDSS	A Ptak	0510204	ApJ 637:147 (2006)
A Search for the Most Massive Galaxies: Double Trouble?	M. Bernardi	0510696	AJ 131:2018 (2006)
Spectral Decomposition of Broad-Line AGNs and Host Galaxies	D. Vanden Berk	0509332	AJ 131:84 (2006)
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The SDSS View of the Palomar-Green Bright Quasar Survey	S. Jester	0506022	AJ 130:873 (2005)
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The Nature of Nearby Counterparts to Intermediate Redshift Luminous Compact Blue Galaxies. II CO Observations	C. Garland	0502055	ApJ 624:714 (2005)

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{\em XMM-Newton} and optical follow-up observations of three new Polars from the Sloan Digital Sky Survey	L. Homer	0411175	ApJ 620:929 (2005)
Rotation Velocities of Two Low Luminosity Field Galaxies	J. Pizagno	0410672	ApJL submitted
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Colors, Magnitudes and Velocity Dispersions in Early-Type Galaxies: Implications for Galaxy Ages and Metallicities	M. Bernardi	0409571	AJ 129:61(2005)
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Optically Identified BL Lacertae Objects from the Sloan Digital Sky Survey	M. Collinge	0411620	AJ 129:2542 (2005)
The Properties and Luminosity Function of Extremely Low Luminosity Field Galaxies	M. Blanton	0410164	ApJ 631:208 (2005)
The Environmental Dependence of Galaxy Properties in the Local Universe: Dependence on Luminosity, Local Density, and System Richness	M. Tanaka	0411132	AJ 128:2677 (2
Spectroscopic Properties of Void Galaxies in the Sloan Digital Sky Survey	R. Rojas	0409074	ApJ 624:571 (2

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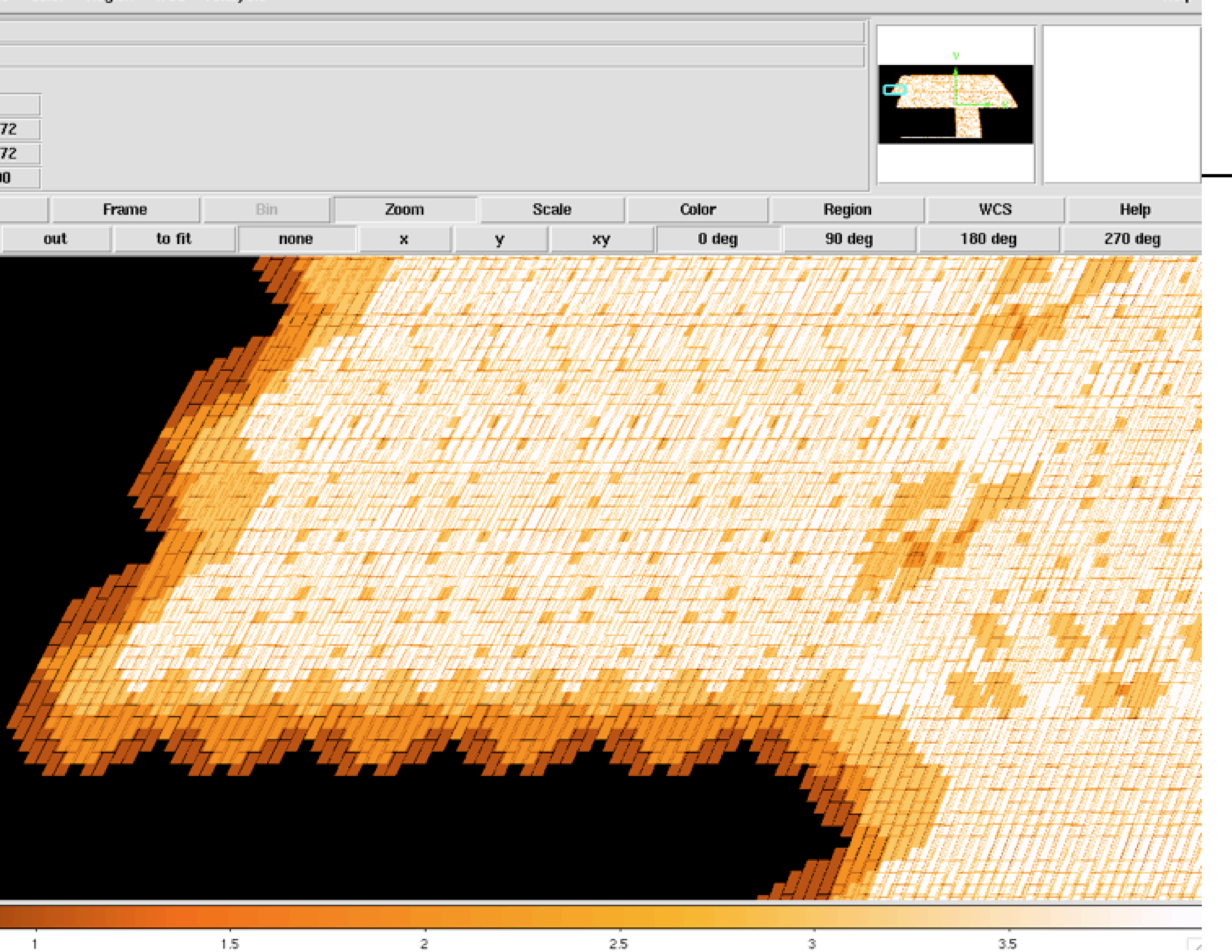
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DARK ENERGY SURVEY

Institutions Participating in the DES Collaboration

- **Fermilab**
- **University of Illinois at Urbana-Champaign**
- **University of Chicago**
- **Lawrence Berkeley National Laboratory**
- **University of Michigan**
- **NOAO/CTIO**
- **Spain-DES Collaboration:**

  Institut d'Estudis Espacials de Catalunya (IEEC/ICE), Institut de Fisica d'Altes Energies (IFAE), CIEMAT-Madrid:
- **United Kingdom-DES Collaboration:**

  University College London, University of Cambridge, University of Edinburgh, University of Portsmouth, University of Sussex
- **The University of Pennsylvania**
- **Brazil-DES Consortium**
- **The Ohio State University**
- **Argonne National Laboratory**

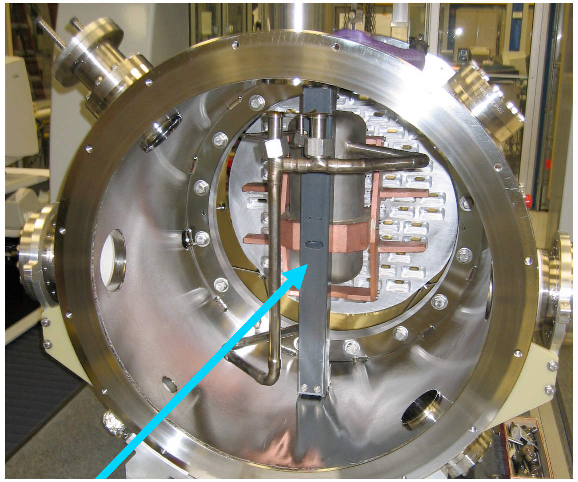
Advice to DOE and NSF and the FY08 Budget Request

- DETF and P5 delivered their reports to HEPAP in July 06: the former recommended the rapid start of a Stage III experiment like DES and the latter recommended starting DES construction in FY08. HEPAP forwarded the reports to DOE and NSF and recommended supporting the roadmap, which included DES.

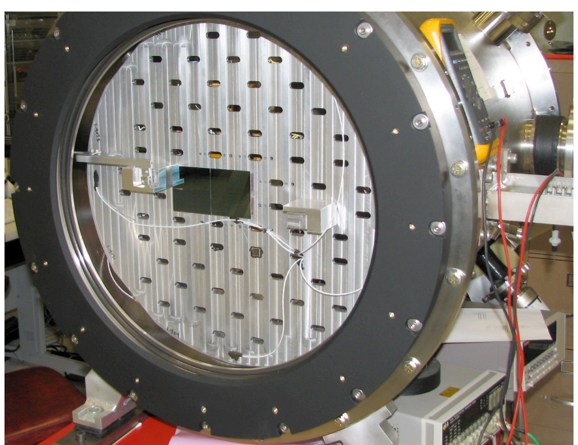
- The DOE FY08 Congressional Budget Request contains a request for DES MIE funding for $3.6 M, with the caveat that funding in FY 2008 is contingent on successful scientific and technical readiness reviews by the interested funding agencies.

DARK ENERGY SURVEY

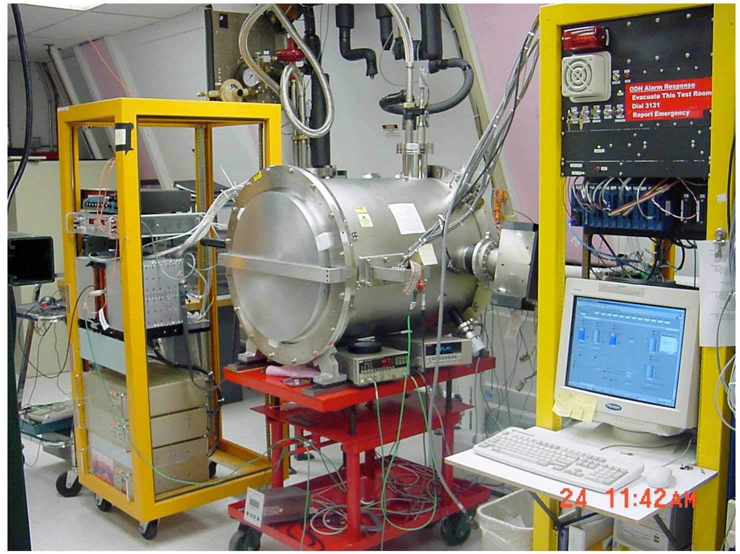
Experiences with Multi-CCD Test Vessel



Cooling system Installed



Focal Plate with 4 CCDs and Window



Mechanical Ongoing Efforts:

- Operate Focal Plate

Temperature Control system

- Measure Focal Plane Flatness

Progress:

- Vessel Construction experience for BoE
- Focal Plate metrology during assembly
- Cooled Focal plate -100 C
- Control system operations includes:
  - Labview operated LN2 fill system
  - Labview monitors focal plate temps.
- Testbed for control system with ANL and WBS 1.5.3
- Vacuum system confirmed

2e-6 torr Turbo Pump, 2e-7 torr Turbo + Cryopumping

4e-7 Ion Pump and Cyropumping

- Installed Optical Window